



**NACE  
TX/LA  
Gulf Section**

TO PROTECT  
PEOPLE, ASSETS, AND THE ENVIRONMENT  
FROM CORROSION

**A NACE SECTION**

# OILFIELD INTERNAL CORROSION INHIBITOR FUNDAMENTALS

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# OVERVIEW

- Corrosion Inhibitor Classification
- Corrosion Inhibitor Formulation
- Corrosion Inhibitor Application
- Batch Treatment
- Continuous Treatment
- Pipeline Treatment
- Corrosion Inhibitor Considerations
- Conclusions

# CORROSION INHIBITOR CLASSIFICATION

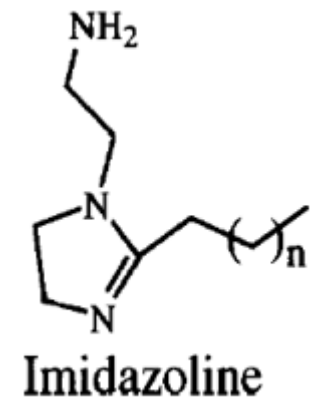
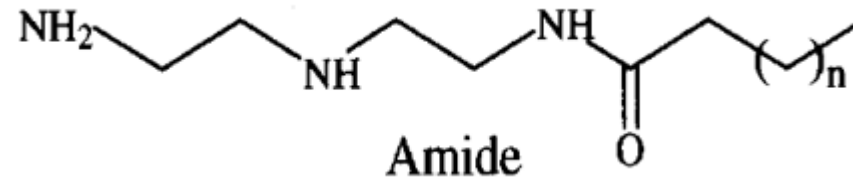
- Film Forming
  - Protective diffusion barrier
  - Steel wettability hydrophobic not hydrophilic
  - Effective for CO<sub>2</sub> and H<sub>2</sub>S corrosion
- Oil Soluble
  - Lower water cut
  - Stratified or turbulent flow / high velocity
- Water Soluble
  - Typically used with higher water cut
  - Stratified or turbulent flow
- Oil Soluble / Water Dispersible
  - Can be used with all water cuts
  - Partitioning

# CORROSION INHIBITOR FORMULATION

- Surface active agents
  - Active Ingredient
    - Imidazoline
    - Amides
    - Quaternary Amines
    - Dimer / Trimer Acids
  - Solvents
    - Glycol, alcohol, EGMBE, water, aromatic / aliphatic solvents
  - Surfactants
    - Nonylphenol, ethoxylates, phosphate esters

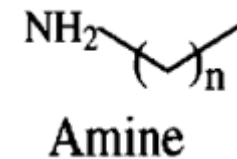
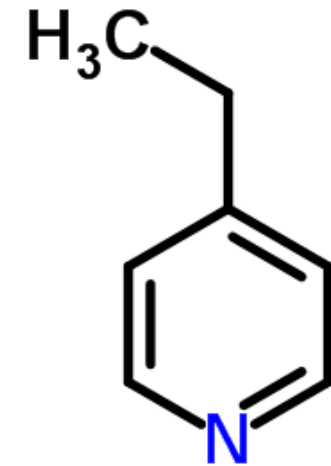
# CORROSION INHIBITOR FORMULATION

- Imidazolines / Amides
  - Batch or Continuous
  - Wide range of applications
  - Effective in gas streams
  - High temperature and velocity tolerant
  - Environmentally unfriendly – Imidazolines
  - Environmentally friendly – Amides



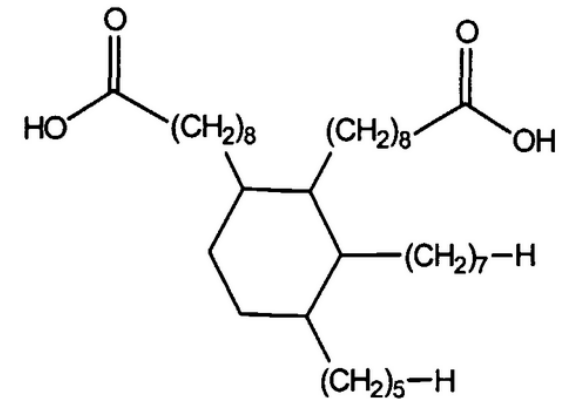
# CORROSION INHIBITOR FORMULATION

- Amines
  - Quaternary Amines
    - Effective in sweet and sour conditions
    - Effective in high velocity conditions
    - Environmentally unfriendly
    - Aids in partial water phase partitioning



# CORROSION INHIBITOR FORMULATION

- Dimer / Trimer Acids
  - Batch applications
  - Oil soluble
  - Effective in sweet and sour conditions
  - Synergist with imidazoline
  - Environmentally friendly



# CORROSION INHIBITOR APPLICATION

- Downhole
  - Batch via squeeze
  - Batch via annulus (Shot truck / Flush)
  - Continuous via gas lift / capillary string
- Production Multiphase
  - Batch via cleaning pigs
  - Continuous injection via atomizer or quill



# CORROSION INHIBITOR CONSIDERATIONS

- Stability
  - Thermal
  - Foaming
  - Gunking
  - Compatibility – (Metal, Elastomer, Fluids)
- Solubility / Dispersibility
  - Partitioning
- Corrosivity
  - Metallurgy
  - Injection methods
- Application Constraints
  - Temperature
  - Velocity



# BATCH TREATMENT

- Advantages
  - Excellent initial coating on pipeline or production tubing
  - Cost effective
  - Infrequent treatments needed to refresh 3 mil coverage
  - Application between cleaning pigs
- Disadvantages
  - Requires more manpower
  - High initial concentration required
  - Half life of film will vary as production progresses
  - Cannot stabilize emulsions or film tenacity suffers

# BATCH TREATMENT

- Pipelines
  - Pig pipeline prior to application of film
  - Pig removes biofilms for more steel surface area
  - Typical initial calculation is 3 mil thick film
    - 1 mil thickness= 0.86 gallons per diameter inch per mile
  - MPY measurements from coupons every 30 days
  - Amine residuals to verify inhibitor concentrations

# CONTINUOUS TREATMENT

- Oil Pipelines
  - ~10-200 ppm/v based on total fluids
  - Water Soluble – Stratified Flow / High Water Cut
  - Oil Soluble / Water Dispersible – Emulsions
  - Injected using quill near wellhead
- Gas Pipelines
  - ~2500 ppm/v (derived from BS&W)
  - ~2 pints per 1MMSCF
  - Injected using atomizer near wellhead
  - Neutralized product



# CONTINUOUS TREATMENT

- Advantages
  - Effective dispersion
  - Rates can be varied with no initial loss
  - No shutdown required
  - Multifunctional methods
- Disadvantages
  - Equipment costs (Capillary String, Gas Lift, Quill / Atomizer)



# CONCLUSIONS

- Corrosion inhibitors are a cost effective measure for production
- Water Soluble, Oil Soluble, Oil Soluble / Water Dispersible
- Complex formulations for specificity
- Extend the service life of lower grade steels (C1018)
- Myriad of potential applications for tailored protection
- Effective in sweet and sour environments